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The mountains were uplifted after cretaceous beds were laid down in the great sea that covered all that is now western North America. The cretaceous and older strata are, on the flanks of the mountains, turned up on their edges, as at the Garden of the Gods. After this upturn, the tertiary lakes were formed and the surface formations of the plains deposited in them. There has been some uplift since, but the eroding forces have been at work on the plains as well as on the mountains, and some of the forms into which the mountains have been carved have been repeated on the plains. Fantastic carvings of arches, niches and temples are cut in miocene grit or cretaceous chalk. Monument rocks, mounds and promontories are cut by weather in Dakota sandstones, tertiary clays, or triassic red beds, and these forms in secluded valleys, near to or remote from railways, become places of resort; and the bracing air of the prairies, the skies as clear as those of Italy, the sea-like horizon, with the fertility of the prairie soils, all combine to assure us that the great plains shall be the abode of an abundant, healthy and intellectual population, which in the years to come will, perhaps, do some honor to us, as those who strove to implant, with the maize and the wheat, also the seeds of science and a love of truth on the great plains of America.

[Then followed an exhibit of the various kinds of scenery of the plains, from the moraines of North Dakota to the cañons of Texas, by transparencies in the stereopticon illumined by strong electric light, and manipulated by Professor Blake, of the State University.]

THE ORIGIN AND EVOLUTION OF THE HUMAN FACE.

BY A. H. THOMPSON, TOPEKA, KAS.

Of Evolution. It is not necessary at this late day, in the twilight of the nineteenth century, to defend evolution. To the truly scientific mind it has become a great working principle, like gravitation, and is no longer a theory or mere hypothesis, that is open to doubt and criticism. It rests secure upon the very pedestal of nature itself. The book of nature is the record of evolution. Every animal and plant carries in its structure the history of the origin and development of its species. The growth of an individual is an epitome of the evolution of the species. The development of an organ is the history of the origin and evolution of a function, or, indeed, of its decay, as when an organ dwindles to a rudiment from disuse.

Birth, growth, origin, development, genesis, evolution, inception, unfolding, are inseparable from the life history of every species, of every individual, of every organ, of every tissue, of every cell. As the individual has grown, so has the species. The principle of evolution applies to all and explains all. It is the working principle of biology, and to the scientific biologist requires no laudation nor explanation.

Prof. Joseph Le Conte says ("Evolution and Religious Thought") that "Every individual animal body has become what it now is by a gradual process. Commencing as a microscopic spherule of living but apparently unorganized protoplasm, it gradually added cell to cell, tissue to tissue, organ to organ, and function to function; thus becoming more and more complex in the mutual action of its correlated parts, as it passed successively through the stages of germ, egg, embryo, and infant, to maturity. This ascending series of genetically connected stages is called the embryonic or ontogenic series, the genesis of the individual." Again, he says: "Embryonic development is the type of evolution; and evolution is continuous, progressive change, according to certain laws and by means of resident forces. . . . Commencing with the lowest, unicelled, microscopic organism, and passing up the animal scale as it now exists, we find a series of forms similar to, though not identical with, the embryonic series. Here we again find cell added to cell, tissue to tissue, organ to organ, and function to function, the animal body becoming more and more complex in structure, in the mutual action of its correlated parts and the mutual action with the environments, until we reach the highest complexity of structure and of internal and external relations only in the highest animals."

Of the Origin of Man. It is not yet possible to trace the descent of man back to the primeval protozoan, which was the origin of all life. His genealogy can only be approximated, and must forever remain a mystery. The process of the evolution of animal life does not form a continuous ladder from the lowest to the highest, for there are many breaks and missing links. The protozoan is the lowest subkingdom, the vertebrate is the highest, but the line of ascent from the one to the other is not homogeneous, nor continuous, nor symmetrical.

Man is a vertebrate animal, but the course of his descent, even after the differentiation of the mammalia from the vertebrate series, is very uncertain. He retains morphological affinities with so many and sometimes widely separate branches, that he is not related so very closely to any of them. He most resembles the anthropoid apes, of course, but it is only by parallel — not direct — descent that he is related to them. He is not descended from them, but from a common ancestral form with them, which, in its turn, was descended from a common progenitor of other vertebrates. When the genealogy of man shall have been worked out as completely as that of the horse, for instance, we shall have a wonderful biological history, but for the present that history is incomplete. Darwin says ("Descent of Man"): "The most ancient progenitors in the kingdom of the vertebrata probably consisted of a group of marine animals resembling the larvæ of existing ascidians. These animals probably gave rise to a group of fishes as lowly organized as the lancelet, and from these the ganoids and others, like the lepidosiren, must have been developed. From such a fish would arise the amphibians — the fish-like reptiles — and from these the true reptiles and birds. These are closely connected with the monotremata, which connect mammals and reptiles in a degree; but the line of descent of the higher vertebrate classes — mammals, birds, reptiles — from the lower classes — amphibians, fishes, etc. — is obscure. But from the monotremata arose the marsupials, which were the early progenitors of the placental mammals. We may thence ascend to the lemuridæ, and thence the interval is not very wide to the simiadæ. The simiadæ then branched into two great stems — the new-world and the old-world monkeys — and from the latter, at a remote period, man proceeded." Not from the forms that now exist, however, but from a common progenitor with them. Our study of the face will, therefore, need to be comparative, perhaps, more than genealogical, except in the few instances in which there is evident descent. There are gradation stages plainly evident, as the facial parts arose from the lower, headless forms of animals, which possessed neither face nor separate sense organs.

Of the Special-Sense Organs and the Origin of the Face from Them. The mere structures of the face arose from its parts having been evolved and erected for the accommodation of some of the special-sense organs. In fact, we must place its origin at the time of the differentiation of the special senses, when special structures were demanded for their support and protection. We follow backward along the path of the evolution of the face, and find its origin in the differentiation of the four facial senses. But, previous to this differentiation of sensation into the various special senses, we observe that unspecialized nervous organization preceded function, unless, indeed, sensation exists without and preceded nervous organization.

"It is well known that the protozoans—sponges, cœlenterates, infusoria, etc.—depend for sensation and motion upon the irritability and contractability of protoplasm," says Mr. A. S. Packard ("Standard Natural History"). Again: "A genuine nervous organization for the first time appears in the jelly fishes. The echinoderms, starfish, etc., have a mere nervous ring, but probably without ganglia; but in all other invertebrate animals, from the worms and mollusca to the crustaceans and insects, the nervous system consists generally of a pair of ganglia above the esophagus, called the brain, on the under side a second pair, and the four ganglia, with the nerves and commissures connecting them, is often called the esophageal ring, from which slender threads reach away to the various parts of the body. In some forms the lower pair of ganglia are missing, and others have another pair, the visceral ganglia, added. In the higher worms, crustacea, and insects, there is a chain of ganglia or brains which are ventral, and line the floor of the body cavity. In the very highest invertebrates there is a mass of ganglia, as in the head of the cephalopods. In the vertebrates the brain is more simple, consisting of a series of close-set ganglia, forming a mass situated in a bony case, the skull, with the spinal cord extending through the vertebræ and having a definite relation to the sense organs, and sending branches to all parts of the body.

"The tactile sense, or sense of touch, is common to all animals. It is the fundamental sense, of which all others are but modifications. The most conspicuous sense organs are the eyes. A transparent spot on the front of some lower forms is probably the simplest of all sense organs, and anticipates the eye of higher animals. The simplest form of eyes is perhaps those of the sea anemone, in which there are, besides pigment cells, refractive bodies, and from this true eyes develop as the scale of life advances. In some worms true eyes appear—a projecting, spherical lens, behind a vitreous body, retina, and optic nerve. In the crustaceans, the eyes assume a quite definite place in the head, except in a few instances. In insects the eyes, both simple and compound, are located definitely on the head. In the skulled vertebrates, the eyes are of definite number, and in all types occupy a definite position in the head.

"The simplest kind of auditory organ is found in the jelly fishes, the first lower form in which it appears. The otocysts, or simple ears, of the worms and mollusks are minute and usually difficult to find, as is the auditory nerve leading to the nerve centers. In the clams the ears are in the so-called foot; in the cuttle-fish and snails, in the head close to the brain; in the shrimps and crabs, at the base of the mandibles; in a few other crustaceans, at the base of the tail. In the insects there is a real tympanum cavity—a sac with a ganglionic cell within, but the position is very variable. In the locusts, the ears are at the base of the abdomen; in the katydids and crickets, in the fore tibia; in the butterflies, probably in the antennæ, etc. In the vertebrata the ears are two in number, and are definitely situated on the sides of the head. The sense of smell is obscurely indicated by special sense organs in the invertebrate animals, nasal organs, as such, being characteristic only of the skulled vertebrates. The organ of taste seems to be specially differentiated only in the vertebrates, so far as we can tell."

Our field is thus reduced to the vertebrates, for the sense organs are so scattered throughout the body in the invertebrates that there is really no such part as the face, in that class, as understood when speaking of the vertebrates. It is in this latter class only that this part becomes apparent as the seat of four of the special senses. How, then, does the face originate and develop in the vertebrata?

In the vertebrates (Mr. Wright, *op. cit.*), "all the higher sense organs may be regarded as differentiated parts of the skin, the nerves of which have become greatly specialized, and have thus acquired a more marked individuality than the other sensory nerves. . . . Regarding the auditory organs, in the fishes only the internal ear is present, without the additional drum cavity and external ear which we find in the higher forms. In the sharks the auditory labyrinth is surrounded by cartilage, but in most fishes it is free. . . . The higher vertebrates carry out the plan begun in the sharks, the labyrinth being completely protected by an osseous capsule." Audition is assisted in some of the higher forms by the erection of a sort of sounding-board from the integument—the external ear. This becomes a very expressive feature in some forms, as in *Equus*.

"The eye is rather more elaborated regarding its internal structure in the higher vertebrates," and its position in the face is such as to make it a very important adjunct in expression. It is considered to convey as much expression as the facial features, and becomes expressive at an earlier stage in the evolution of the face. That is, animals which have little or no facial expression, whose features are undeveloped and immobile, have eyes which are very expressive, and indicate the feelings and passions with no uncertain signs. Its supporting structures have little influence in modifying the features, as they are not extensive in the class.

The olfactory sense organ is more important, regarding the influence it has in modifying the facial contour of animals. The structures erected for its accommodation present great variety, and are often very extensive. The organ of smell "first appears as an involution of the skin in the lowest forms, and in *Amphioxus* is represented by a ciliated sac near the anterior opening of the neural canal," and retains this relative position in all vertebrates. "In fishes the forms of this organ are very various, but in the sharks a groove leads to the roof of the mouth, which is afterward changed into a canal in other higher forms." From this beginning the organ is developed in various forms, and in some animals, as the ruminants, an extremely extensive structure is erected, with long and high nasal bones and large turbinated bones, for its accommodation.

How much the sense of taste has had to do with the development of the tongue, and consequent effect upon the oral structures, we can form no estimate, for these structures seem to be erected mainly for the accommodation of the dental armature. The jaws vary as the food habits cause the teeth to vary, or as the teeth may be developed for other purposes. As these are modified to adapt them to the food habits, the jaws are formed to support the teeth, as, for instance, in the carnivora or the ruminants. The mouth is developed, from a mere orifice for the reception of food for its introduction into the alimentary canal, to the position of an important facial feature. In the higher forms the lips advance from mere prehensile organs to becoming conspicuous features in facial expression, for in man the mouth is the most expressive of the mobile features.

Regarding the face in general, in the lowest vertebrates (Mr. Wright, *op. cit.*)—the tunicates, acrania, etc., those headless vertebrates which are scarcely differentiated from the mollusca and were long classed with them—there seems to be little or no provision for the special senses, and, of course, no trace of a face. In the lampreys occurs the first indication of a skull, and two eyes are present, the proper vertebrate number. The sharks have the eye and ear organized much like the higher vertebrates. The mouth is placed back of the tip of the snout, and in this class the lower jaw begins to assume the form of the higher vertebrates. Throughout the class of fishes there is little to be learned as to the face. The skull is well developed, the eyes are large and expressionless, and the mouth is moved forward to the end of the snout. In the eels the face has advanced a little, and is nearer the reptile form. Many curious forms of fishes have remarkable, often grotesque, facial forms and expressions—if such low faces can be said to have expression. Comparative physiognomy could liken them to many curious human physiognomies to which they bear resemblance.

In the batrachians, intermediate between fishes and reptiles, we find similar expressionless faces, and but little further elaboration for the accommodation of the sense organs. Being amphibious, however, there begin to be some special structures for nasal breathing. The prominent eyes of the toads and frogs are conspicuous features. The mouth is still a mere slit in the integument for the admission of food, and the outer ear does not yet appear.

In the snakes, the face is still an expressionless area of the integument, but the cruel eyes display the vicious passions. Any variation of expression in the ophidia is in the degree of the vindictive emotions—they live to kill. In the lizards begins the first suggestion of expression of the better emotions, for they really have a benign. or at least innocent, face in some species. Other reptiles are grotesque or vicious or expressionless, the face being a mere mask of scale mail, as in the crocodiles. In the birds, modified from the reptilian ancestors from which they are descended in common with contemporaneous reptiles, there is little facial expression, but, as a class, they convey all variations of the emotions through the eyes, which are very eloquent. The nasal structures have considerable development, in some forms, and the extensive jaws are covered with horny sheaths called "the bills," or mandibles, which are varied infinitely to accommodate them to various foods and other purposes.

In the lower mammals, there is not much advancement, in the shape of the face and the structure of the sense organs, from the reptiles. The outer ear appears, and adds to the expression of the face in various ways. The nasal structures are extended, the mouth widens, and the lips appear. In the rodents, the face is shortened and the lips are elongated. The elephants have considerable elevation of the forehead, which gives them the appearance of the intelligent character which they possess, although this elevation is not due to brain, but to bone and air cells. The other pachyderms have flat and expressionless faces, there often being extravagant elongation and enlargement of the mouth. The horns on the nose of the rhinocerous do not add to his beauty, and the face of the hippopotamus is not to be coveted! The face of the horse seems much distorted by the great elongation of the oral and nasal structures, but the ears are the most expressive features in this genus. In the ruminantiæ—especially the deer family—the face is elongated for the accommodation of the extensive nasal sense organ and the masticating area. Perhaps the sense of taste is more developed in the animals that have larger tongues, for discrimination in regard to foods, but of this we have no knowledge. The eye is large, beautiful and expressive in this class.

In the carnivora, we find the face shortened below and widened above, to accommodate the peculiar jaws, which are short and strong, for tearing flesh. In accordance with the habits of the class, the face is often cruel and vicious, and becomes ferocious and terrifying when the destructive passions are aroused. We first meet here some expression in the features, for the mouth and lips, eyes and ears, can be made to express affection, fear, defiance, anger, etc., as in the cat and dog.

In the primates, we expect to find the closest approach to man, for, in the process of collateral development from a common ancestry with them, man has retained many of their peculiarities. We can follow the evolution of the face pretty closely by studying it in this class from the lowest to the highest forms. In the lowest of the primates, the lemurs, there is little change from the carnivorous mammals. The face is covered with hair, and devoid of expression. The ears are large, but have become more or less motionless; the eyes are expressive; the nasal and oral parts are reduced, but the face is still that of the mammals. The lower incisors are usually inclined forward, are not vertical, so there is no chin.

Advancing to the monkeys proper, we find a sudden change. The face becomes at once the seat of expression, and even the little marmosets have considerable facial expression. The face is more or less bare, and the features become mobile, the eyebrows and lips being very active. But the nose is ill-developed, embryonic, in fact, and is especially deformed in the new-world monkeys, in which the nostrils are set wide apart and look outward — not close set and looking downward, as in the old-world monkeys. The upper lip is wide and stiff; the mouth begins to have some expression, but the chin is still absent. The mouth has a characteristic upward curve at the center, and dips downward at the corners — a quadrumanous characteristic which reappears in many coarse human mouths, as many quadrumanous peculiarities do thus reappear in the face of man. Various parts of the faces of monkeys may be covered with whiskers of various colors, especially the lower part of the face and chin.

The baboons have a long, dog-like face, the nose, mouth and chin resembling the canidæ. In some forms, as the drills and mandrills, the face is peculiarly marked by highly-colored skin. The remarkable cheek pouches, which are used for carrying food, are a characteristic of many of the baboons.

The Anthropomorpha comprise the man-like apes — the orang-outang, the chimpanzee, and the gorilla, as these, taken together, approach man most nearly in general structure. One species resembles him in one part and another in a different part. None of them are very close, of course; but it has been often remarked that there is less difference than between the highest apes and the lowest quadrumana, the lemurs. The lowest savage differs from the highest civilized man almost as much as he does from the apes.

In the orang the forehead is full and rounded, and the face less brutal and ferocious than in the gorilla. The head is pointed and high, and the shape of the brain more like that of man than that of any of the other apes. The lips are long, full, projecting, and expressive. Their forms are recalled by the negroid and Celtic races of man, and perhaps others.

The troglodytes include the chimpanzee and gorilla. The latter has strong and high supra-orbital ridges, erected for the attachment of enormous muscles, which give him a ferocious and forbidding appearance. The ridges reduce the apparent height of the brain case also. In the chimpanzee the whole face is more like that of man, the ridges being reduced and the face less brutal than in the gorilla. The head is not so pointed as that of the orang, but higher than that of the gorilla. The flat condition of the external nares gives the chimpanzee's face an immature look. In the young the face is almost human, but the supra-orbital ridges and retreating forehead grow and increase with age, bringing out the animality. The ears are more like those of man, and the lips are neither so extensile nor so large as in the gorilla and orang. The face in the apes is bare, brown skinned, and much wrinkled.

Professor Mivart (in "Man and Apes") is uncompromisingly opposed to the theory of the descent of man from an ape-like ancestor. He delights especially in debasing the much-vaunted gorilla as the near relative of man, and seeks out resemblances in other primates that bring them just as near, or nearer, to man. But these also prove the position of the evolutionist and the defender of the hypothesis of the common origin of man and the quadrumana; for it is the resemblances in the class in general, and not in any one species, that he would look for. Professor Mivart says: "The gibbons are more human than the orang, the chimpanzee, or gorilla, as to the preponderance of the brain case over the bony face. But the smaller American monkeys exceed the gibbons in this respect, while the squirrel monkey exceeds man himself. A striking feature of the human skull is the prominence of the inferior margin of the lower jaw in front—*i. e.*, the presence of the 'chin.' This feature is quite wanting in even the highest anthropoidæ. A more or less developed chin exists, however, in some lower forms, as the siamang, although no other ape or lemur shows a similar condition. Another marked human cranial character is the projection and transverse convexity of the bones of the nose. This convexity is quite absent in the chimpanzee and in most gibbons. In the orang these bones are exceedingly small and flat, often even uniting into one bone or with the adjoining jawbones, if indeed they are not altogether absent. In the gorilla they are slightly convex transversely at their upper part, so that here we seem to have evidence of the predominant affinity of the gorilla to man. Further examination, however, shows that this character can have no such meaning, since a still more decided convexity is found to exist in some Semnopitheci, and even in the lowest baboons. In the latter the nasal bones only become more convex toward maturity, being at first flat. . . . Now it is not the chimpanzee, certainly not the gorilla, nor yet the gibbon, which most resembles man as regards his brain. In this respect the orang stands highest in rank. The height of the orang's cerebrum in front is greater in proportion than either the chimpanzee or gorilla, while the brain of the latter is below that of the chimpanzee; so that this much-lauded ape is inferior to both the orang and the chimpanzee. The simian's faith is at fault, and the pretender gorilla must abdicate in favor of two better claimants at least."

Professor Huxley says ("Man's Place in Nature"): "In the gorilla the face, formed largely by the massive jawbones, predominates over the brain case; in man the proportions of the two are reversed. In man the surface of the skull is smooth, and the superciliary ridges or other prominences usually project but little, while in the gorilla vast crests are developed upon the skull, and two strong ridges overhang the cavernous orbits like great penthouses. Sections of skulls show, however, that some of the apparent defects of the gorilla's cranium arise in fact not so much from deficiency of brain case as from excessive development of parts of the face. The cranial cavity is not ill shaped, and the forehead is not truly flattened or very retreating, its really well-formed curve being simply disguised by the mass of bone which is built up against it. . . . It is the large proportional size of the facial bones and the great projection of the jaws which gives the gorilla's skull its small facial angle and the face its brutal character. . . . The lower apes and monkeys exaggerate the general proportions of the muzzle of the great anthropoid, so that his visage looks mild and human by comparison with theirs. The difference between the gorilla and the baboon is even greater than it appears at first sight, for the great facial mass of the former is largely due to a downward development of the jaws; a certain human character, superadded upon that almost purely forward, essentially brutal, development of the same parts which characterizes the baboon, and yet more distinguishes the lemur. . . . The orang's skull is as devoid of excessively developed superciliary prominences as man's, though sometimes exhibiting crests in other places. In some of the cebine apes or others the cranium is as smooth and rounded as that of man himself."

The truth is that the divergencies are so many and the resemblances so few that none of the anthropomorpha are really very near to man. Still, the class, taken together, presents many indications of relationship. In the facial form and features there are many such resemblances, evidencing the collateral development as well as the relationship of the face in man and the quadrumana.

The human face, like the remainder of the mere tenement of the soul, came up through many vicissitudes to its present beauty and perfection. As Huxley again says (*op. cit.*): "Our evidences of the nobility of manhood will not be lessened by the knowledge that man is, in substance and structure, one with the brutes; for he alone possesses the marvelous endowment of intelligence and articulate speech, whereby, in the secular period of his existence, he has clearly accumulated and organized the experience which is usually lost in other animals." The face indeed has developed from the highest plane of animal life to that highest plane of human life, where we find its perfection, along with the development of that higher intellectual power which dictated its superior formation. The path by which the mutual and simultaneous development of the face and mind was accomplished after the mere brute was left behind is entirely lost; but we know by the wonderful results that there was such a growth, sometime, somewhere. The face and brain were developed collaterally, and the high perfection of the face in man is due to his high brain development. It is unfortunate that the paleontological history of man has not been recovered; but when it is found, this, among other important questions, will receive a flood of light. For the present, we must be content with studying the evidences of the evolution of the face in the collateral animal branches and in the embryological record.

We turn next to the record of *embryology*, which is, in many respects, much more clear and continuous in the genetic evolution of the face than the comparative record. The latter is sadly mutilated and broken, so that only in a very few instances, as in the case of the horse, can the history of the development of a species be made out at all. Contemporaneous species give us an analogical history only, but we can judge from them what the evolutionary history of man must have been like. That far we are positive, however, for the assumption is borne out by the history of the few species in which the record is complete, and we must reason from analogy that those whose record is incomplete must have had a similar history of evolution and development. Man is, unfortunately, one of the species in which the record is most incomplete; but judging from analogy, we necessarily infer that he must have had a similar process of evolution. From this induction there is no escape.

The Mind of Man. But to his animal organization there is superadded the conspicuous peculiarity of a high intellectual growth which is absolutely unique, and which sets him apart in a great department of his own. No other animal approaches him in regard to mass of brain or mental power. The history of the development of this remarkable faculty is entirely lost, for we are as yet in total ignorance of the barest hint of the process by which it arose. We are not convinced that it could have been developed from an ordinary animal intelligence, for the mind of man has many qualities which set it apart and distinct from the animal mind. It is these qualities of mind and the victories over nature, and great achievements by reason of these qualities, which distinguish man from the mere animal. It does not seem possible that they could have been developed from the animal mind, so far as we know the latter by its phenomena; but as we know it *only* by its phenomena and cannot become *en rapport* with it, we cannot judge finally. We may yet be permitted to accept the final cause of a supernatural interference in the process of the creation of the human mind as a distinct and peculiar endowment of our species, which cannot be accounted for by the natural processes with which we are acquainted.

Be the source what it may, the human mind is a powerful factor in influencing the evolution of the face, and to this is due the high development of that area of the human body as an expressional organ. The influence of the mind upon the face in the individual is, however, mainly postnatal; for whatever this may be in utero is probably only hereditary, with, perhaps, some occasional effect from transient maternal emotion. Without stopping to dwell upon this, we pass now to the study of the evolution of the face from the embryological aspect, in addition to its anatomical history from the comparative standpoint. This will lead us to a better understanding of the unfoldings and unfoldings, through past germinal forms, through which the human face has come, up to the perfect flower of to-day.

We notice at the outset that the subject of the *embryological history of man is greatly misapprehended*, although, as we have noticed before, it is simple in its principles, when studied from the evolutionary and comparative standpoint. We have been a long time in accepting the self-evident fact that the human embryo passes through stages of evolution that recall and illustrate the growth of the species; for the growth of the embryo is, in fact, an epitome, a panorama in miniature, of the growth of the species. It presents, at various and successive steps, conditions and parts which are permanent in lower animals. At first it resembles the very lowest forms, then those next higher, then those still higher, and then again higher, until its own type is reached, when its form, in turn, becomes permanent. Its growth simply illustrates the growth of the species, and, by graded stages of resemblances, points out the path by which its own type was reached in the evolution of the species. But simple as this fact is, it remained unrecognized for long years, and is, indeed, understood by but few intelligent people even now. Prof. Ernst Haeckel, in "Evolution of Man," writes at length of "Anthropogeny," as the evolution of man is christened. "It is surprising," he says, "to see what a little way the knowledge of human evolution has spread, even among the very students of nature." Or again ("History of Creation"): "The facts of embryology would alone be sufficient to solve the question of man's position in nature, which is the highest of all problems, for their philosophical importance cannot be too highly estimated. He proceeds to explain this important branch of science, and begins:

"Our first principle of biogeny is, the evolution of the germ is a condensed evolution of the tribe, and the reproduction is more complete in proportion as, in consequence of constant heredity, the original inherited evolution is more closely realized."

Haeckel again says ("Evolution of Man"): "At a certain period in the development of the human embryo it has essentially the anatomical structure of a lancelet, later of a fish, and, in subsequent stages, of amphibian and mammal forms; in the further evolution of these mammal forms, those first appear which stood lowest in the series, such as the forms allied to the beaked animals (*ornithorhynchus*); then those allied to the pouched animals (*marsupialia*), which are followed by forms most resembling apes, till at last the peculiar human form is produced as the final result."

The *embryology of the face* is not difficult to follow. It is conceded that its main elements are formed from the remains of the gill arches of the fishes and early vertebrate amphibious forms. In the early embryonic condition of the higher vertebrates, including man himself, we find on each side of the neck several gill slits, each with its gill arch. Mr. R. R. Wright ("Standard Natural History") says: "In the aquatic vertebrates the anterior part of the alimentary canal communicates with the outside by a series of gill clefts on either side, through which the water streams for respiratory purposes. Although these gill clefts shortly disapper, with the exception of the first, in the air-breathing vertebrates, yet they are present in the embryos of all, even of the highest. Between the clefts (also known as the visceral clefts) are solid pillars, visceral folds, which are not developed in the higher forms, except in the first and second arches, the rest being suppressed or nearly so. An actual fusion takes place between the upper arch and the cranial skeleton to form the upper jaw, while the second arch is modified into the lower jaw, the Meckelian part, which is hinged to the upper jaw and suspended from it." From this orgin the jaws are developed in all the higher forms, man included. In the human embryo the origin of the face and jaws is well indicated, the gill clefts being quite conspicuous in the embryo face. Their failure to unite is the cause of that embryological deformity known as harelip.

Of the origin of the vertebrate mouth, Mr. Bettany writes (following Doctor Dohrn, "Nature,") that "the vertebrate mouth is a modern structure, and arises extraordinarily late in development. The embryonic body is almost completely formed, all the great systems are established, while as yet there is no mouth. It does not arise either in the position in which it permanently remains in the majority of vertebrates, but undergoes considerable shifting. Only in some fishes does it retain its primitive situation. The study of its development establishes the idea that the mouth of vertebrates is homologous with the gill clefts."

Haeckel, in "History of Creation," again says: "In all craniota, that is, all vertebrate animals having a skull and brain, the brain, which is at first only the bladder-shaped dilations of the spinal marrow, divides into five bladders, lying one behind the other. This is just the same in all vertebrate embryos, from the lowest to the highest. The whole form of the body is as yet exceedingly simple, being merely a thin, leaf-like disk. Face, legs, intestines, etc., are completely wanting, but the five bladders are quite distinct. The *first* bladder, the fore brain, develops into the hemispheres of the large brain, the cerebrum. The *second* forms the center of sight," etc. . . . "An exceedingly important formation, of which we are not able to recognize a trace in the full-grown animal, are the *gill arches*, which originally are common to all vertebrate animals, but which at a later period are transformed into the most different organs. Everyone knows the gill arches of fish—those arched bones which lie behind one another to the number of three or four, on each side of the neck, and which support the gills, the respiratory organs of the fish. Now, these gill arches originally exist in embryo exactly the same in man, in dogs, in fowls, in tortoises, as well as in other vertebrate animals. It is only in fishes that these remain in their original form and develop into respiratory organs. In the other vertebrate animals they are partly employed in the formation of the face (especially the jaw apparatus) and partly in the formation of the organ of hearing.

"An examination of the human embryo in the third or fourth week of its existence shows it to be altogether different from the fully-developed man, and that it exactly corresponds to the undeveloped embryo form presented by the ape, dog, rabbit, or other mammals at the same stage of their ontogeny. At this stage it is a bean-shaped body of very simple structure, with a tail behind and two pairs of paddles, resembling the fins of a fish. Nearly the whole of the front half of the body consists of a shapeless bud without a face, on the sides of which are several gill fissures and gill arches, as in fishes. . . . In the embryo of man, as in all other vertebrates, the very remarkable and important structures which are called the gill arches and gill openings appear at a very early period, on each side of the head. These are among the characteristic and never-failing organs of vertebrates. . . . The number of these gill arches and of the gill openings between amounts, in the higher vertebrates, to four or five on each side; but the lower forms have a yet larger number. Originally they are used for respiration. In the higher vertebrates they afterwards close, and are transformed partly into the jaws and partly into the bonelets of the ear. Almost simultaneously with development of the gill arches, and immediately behind these, the heart, with its four compartments, is formed, and above, on the side of the head, the rudiments of the higher sense organs appear—the nose, eye, and ear. These highly important organs originate in the very simplest forms. The organ of smell appears quite in front of the head, in the shape of two little pits, above the mouth opening. The organ of sight, also in the form of a pit, comes next behind the organ of smell, toward which a considerable vesicular outgrowth of the fore brain grows on both sides of the head. Farther back appears a third slit on each side of the head, the first rudiment of the organ of hearing."

Or again: "At a very early stage, and while no trace of the characteristic facial structure of man is yet visible, a pair of small grooves appear before the primitive mouth cavity, the primitive nasal grooves. They are separate from the mouth cavity, which also makes it appearance as a groove-like indentation of the external skin, opening in front of the blind anterior extremity of the intestinal canal. This pair of nasal grooves, as well as the single mouth groove, are lined by the external epidermis. The two inner nasal processes or flaps arise right and left of the grooves, and opposite to these rises another groove, between the eye and nasal grooves. A plug-shaped formation projects into the nasal grooves, which is the upper-jaw process. Below the mouth groove lie the gill arches. The first of these develops into the jaw skeleton of the mouth, and is called the jaw arch. A small process first grows out from the base of the first gill arch; this is the upper-jaw process, which forms the principal part of the framework of the upper jaw. On its outer side the bone afterward unites, and in the middle portion the intermaxillary develops for the anterior portion of the frontal process. . . . The external nose is not developed until long after all the internal parts of the sense organ have been formed. It appears at the end of the second month, and grows out to form the process, but the form characteristic of man does not appear until a far later period. In most forms, the nose retains an undeveloped form. . . . The outer protective parts of the eye are merely simple folds of the skin, which appear in the third month. The inner parts originate from the inner structures of the head. . . . The entrance to the intestinal canal is the mouth opening, which is part of the intestinal system, and receives the food, which it passes on to the digestive organs. The external opening originates in a fold or groove-like incision of the external skin, and its membrane is formed from the skin. . . . The original formation of the mouth skeleton, the upper and lower jaws, is traceable to the gill arches."

From these remarkable beginnings there has been developed the human face, with all its superadded powers of expression and physical beauty. The first crude and immature form, as seen at birth, with all its future possibilities, is produced by evolution along the same path which leads to the development of the same parts in other animals, as already noted. The resemblance to lower forms is maintained to the last stage, the last animal resemblance to disappear in the face of the human embryo being that of the apes.

We have now studied the origin and followed the evolution of the face by various paths. Surely the little evidence we have here gleaned from the great field of nature is of itself convincing that the face of man has arrived at its present perfection not by accident, not by one stroke of creative power, but by the simple, philosophical and natural methods of gradual development and evolution, in accordance with nature's laws.

IS THE RAINFALL IN KANSAS INCREASING?

BY E. C. MURPHY, LAWRENCE.

This important and interesting question is one which has been much discussed. The writer's reason for undertaking its discussion at this time is his belief that his division of the record into periods and his treatment of the means of these periods is different from that of other writers, and answers the question asked in the title as